19 July 2016

QGC - ADDENDUM TO HYDRAULIC STIMULATION CHEMICAL ASSESSMENT

Aldacide/ M300A Biocide Hazard Assessment

Some parts of this report have been redacted to maintain the confidentiality of commercially sensitive information

Submitted to:
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ADDENDUM

Report Number. 127635006-019-R-Rev1-05300- Biocide Assessment

Distribution:

1 e-copy QGC

Golder Associates

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Document Number	Issue Date	Revisions
127635006-019-R-Rev0	16 February 2015	-
127635006-019-R-Rev1	19 July 2016	Removal of Fluid Disclosure Sheet from Appendix A and Appendix D – Mass Balance Table. Documents removed to maintain the confidentiality of commercially sensitive information.

1.0 INTRODUCTION

QGC has requested that Golder Associates Pty Ltd (Golder) undertake a hazard assessment of two biocides proposed for use in operations in QGC's Queensland tenements. The assessment is in regards to their potential toxicity to human health and ecotoxicity in aquatic and terrestrial environments.

This addendum presents the hazard assessment of one (1) chemical, glutaraldehyde, the major active constituent in the biocides 'ALDACIDE® G ANTIMICROBIAL' (Aldacide) and 'Protectol® GA 24' (also identified as M300A). Aldacide is proposed for use in drilling fluid treatment and M300A is proposed for use in stimulation activities.

1.1 Background

Golder has previously assessed a number of hydraulic stimulation chemicals for human health and ecological hazards for QGC. The chemical assessments are documented in the report*: Human Health and Ecological Chemical Assessment – Hydraulic Stimulation Chemical Assessment – QGC Surat and Bowen Basin Operation* (Golder Ref. 127635006-004-R-Rev1, dated 21 February, 2014; HSCA report). This assessment is provided as an addendum to the 21 February 2014 Report.

1.2 Chemicals to be Assessed

QGC provided Golder with the following product information relevant to this assessment:

Aldacide

- Biocide Product Data Sheet – ALDACIDE® G (Halliburton, 24 March 2010)
- (Material) Safety Data Sheets (SDS) for ALDACIDE® G ANTIMICROBIAL (Halliburton, 17 August 2012).
- Facility Description Power Point – Dewatering Operations (QGC (no date provided), attached to Kearney 2014, pers. comm.)

M300A

- SDS for Protectol® GA 24 (BASF Australia Limited, 9 October 2013)
- Fluid Disclosure Sheet (FDS) for [redacted] (26 September 2014).

The documents provided by QGC are included in Appendix A, with the exception of the FDS. The FDS has not been included in this report to maintain the confidentiality of commercially sensitive information.

The chemical identified for assessment was that presented in the SDSs for Aldacide and M300A. The information provided in the SDS is outlined in Table 1. Golder also reviewed the FDS provided for the stimulation fluid. Chemicals listed had previously been assessed (Golder, 2014), with the exception of glutaraldehyde.

Table 1: Additional Stimulation Chemicals

CAS RN	Chemical Name	Percent in Aldacide	Percent in M300A
111-30-8	Glutaraldehyde	10 – 30 %	20 – 25 %

Note: CAS RN - Chemical Abstracts Service Registry Number

Golder understands that the proposed use of the two biocides varies. The proposed use is outlined below:

- QGC propose to add Aldacide to the clean water tanks in QGC's two drilling fluid treatment facilities, consisting of a floc tank and centrifuge, which is outlined in Facility Description Power Point (Kearney 2014, pers. comm.). The majority of the treated water is re-used in drilling mud for subsequent drilling activities (Kearney 2014, pers. comm.). A small portion of the treated water may be conveyed into the CSG water management system, where it is stored and treated (Kearney 2014, pers. comm.). QGC

stated that the recommended Aldacide dosage is up to 1.4kg/1000 L and that up to 140,000 L/day of treated water flows through the drilling fluid treatment facilities (Kearney 2014, pers. comm.).

- QGC propose to add M300A to stimulation fluid (as per the FDS referenced above).

1.3 Scope of Work

The approach applied for chemical hazard assessment is documented in the report*: Human Health and Ecological Chemical Assessment – Hydraulic Stimulation Chemical Assessment – QGC Surat and Bowen Basin Operation* (Golder Ref. 127635006-004-R-Rev1, dated 21 February, 2014). This approach was applied to the hazard assessment of glutaraldehyde.

As a part of this assessment, the following scope of work was completed:

- Preparation of a human health toxicological profile on glutaraldehyde (results presented in Appendix B).
- A review of environmental hazards of glutaraldehyde (where possible) using measures of persistence (P), bioaccumulation (B) and toxicity (T) (PBT) and preparation of chemical information sheets and hazard summaries (results presented in Appendix C).
- Mass fraction calculations for the biocide in the water treatment facility and well stimulation.
- Preparation of this technical memorandum.

2.0 GLUTARALDEHYDE

2.1 General

Glutaraldehyde is a colourless oily liquid which has a variety of uses (NICNAS, 1994). The molecular structure of glutaraldehyde is presented in Figure 1, below. Glutaraldehyde solutions, at 50% concentration, are mildly acidic and have a vapour pressure of 2.03 Pa (at 20ºC) (NICNAS, 1994). In the vapour state, glutaraldehyde has a pungent odour, with an odour threshold of 0.04 ppm.

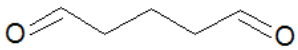

Figure 1: Molecular Structure of Glutaraldehyde

In Australia, glutaraldehyde is primarily used as a disinfectant by the health care industry (NICNAS, 1994). Other uses include as a hardener in x-ray film processing, as a fixative in tanning, as a disinfectant of animal housing, aircraft and portable toilets, as a preservative in industrial oils and as a biocide in aquaculture (NICNAS, 1994). Glutaraldehyde is primarily used as an aqueous solution, ranging in concentration from 50% w/w to less than 1% w/w (NICNAS, 1994). Following environmental release, glutaraldehyde's hydrophilic nature will result in it primarily being associated with aquatic compartments, with little tendency to bioaccumulate (Leung 2001; NICNAS 1994).

Although hydrolysis of glutaraldehyde is slow, like other aldehydes, it will undergo aerobic oxidation in solution. A hydrolysis study reported by NICNAS (1994) lists the extrapolated half-lives for glutaraldehyde as 508 days at pH 5, 102 days at pH 7 and 46 days at pH 9. Degradation at pH 9 occurred more rapidly, with the formation of a cyclic dimer of glutaraldehyde (NICNAS 1994).

In aquatic systems glutaraldehyde rapidly biodegrades in freshwater systems and has the potential to biodegrade in the marine environment (Leung 2001).

Soil adsorption tests have shown glutaraldehyde readily metabolises in soils, with half-lives of just a few days. Degradation appears to occur in both an aerobic and anaerobic environment. In sewers, studies have also shown that glutaraldehyde will undergo biodegradation by sewage microorganisms (although these reactions appear be slower) (Leung 2001; NICNAS 1994).

Bioaccumulation of glutaraldehyde in aquatic organisms is considered to be unlikely due to its hydrophilic nature and limited persistence (Leung 2001; NICNAS 1994).

2.2 Human Health Toxicity

The Human Health Toxicity Profile for glutaraldehyde is included in Appendix B, with the results of the review summarised below.

Occupational exposure to glutaraldehyde has resulted in occupational asthma, significant skin, respiratory system and eye irritation, as well as skin sensitisation in some cases (NICNAS, 1994 and ECHA, 2014). Glutaraldehyde is corrosive to the skin and is a respiratory sensitiser. Based on these hazards, glutaraldehyde has been ranked in the Human Health Toxicity Profile as Hazard Band 3 (1 = lowest, 4 = highest, refer Appendix B).The inhalation hazards associated with use of glutaraldehyde need to be managed in an occupational setting as it can cause asthma.

2.3 Ecotoxicology

2.3.1 Aquatic toxicity assessment

An environmental hazard assessment was undertaken on glutaraldehyde, based on persistence (P), bioaccumulation (B) and toxic (T) potential (hereafter referred to as PBT). The environmental hazard assessment categorises a chemical as having potential to pose a high, moderate or low hazard to the environment.

The Chemical Information Sheet or Ecotoxicology Profile for glutaraldehyde (provided in Attachment C) presents the available physical and chemical information, in addition to selected ecotoxicological data for freshwater organisms from the information reviewed.

An overall score (the environmental hazard score) for glutaraldehyde (organic chemical) was calculated based on the potential for P, B and T. Table 2 summarises the overall hazard score for glutaraldehyde.

Table 2: Glutaraldehyde: Aquatic toxicity score for glutaraldehyde

Chemical	Bioaccumulation Score	Persistence Score	Toxicity Score	Overall Hazard Score
Glutaraldehyde	1.1	1	3	1.7

Note: For further detail see Appendix C

Based on the PBT assessment, glutaraldehyde has been given an overall hazard score of 1.7, indicating that is poses a moderate hazard to the aquatic environment. The moderate hazard classification was based on acute toxicological effects (mortality) in the freshwater algae (*Pseudokirchneriella subcapitata*). Leung (2001) classified glutaraldehyde as acutely toxic to aquatic organisms based on the results for a range of aquatic toxicity tests.

2.3.2 Terrestrial toxicity assessment

The Chemical Information Sheet on glutaraldehyde presents the available ecotoxicological data for terrestrial organisms.

For glutaraldehyde the only terrestrial toxicity data available was for mammals (mice), with an LD_{50} of 100 mg/kg (Table 3).

Table 3: Terrestrial toxicity data for glutaraldehyde

	Mammalian LD_{50}
	mg/kg
Glutaraldehyde	100

Note: LD_{50} – Lethal Dose for 50% of the test population.

2.3.3 Summary of Environmental Toxicity Assessment

Based on both the toxicity data and the behaviour of glutaraldehyde in aquatic (freshwater) and terrestrial ecosystems (the rapid metabolism of glutaraldehyde in soil, its rapid biodegradation in the aquatic environment and that it does not tend to bioaccumulate) glutaraldehyde is considered to be of a moderate risk to aquatic and terrestrial receptors.

3.0 MASS BALANCE CALCULATIONS

3.1 Aldacide – Use in drilling fluid treatment

As mentioned previously, QGC stated that the recommended Aldacide dosage is up to 1.4kg / 1000 L and that up to 140 000 L/day of treated water flows through the drilling fluid treatment facilities (Kearney 2014, pers. comm.).

Based on this information, it is assumed that a maximum of 196 kg of Aldacide is added to the drilling fluid treatment facility per day. Using the Aldacide density (at 20ºC) provided in the SDS (Halliburton, 2012), this would equate to 184.2 L of Aldacide. Based on the assumption the glutaraldehyde forms 30% of the Aldacide solution, a total of 55.3 L glutaraldehyde is assumed to be added to the drilling fluid treatment facility daily.

QGC stated that the majority of the treated water is re-used in drilling mud for subsequent drilling activities (Kearney 2014, pers. comm.). A small portion of the treated water may be conveyed into the CSG water management system, where it is stored and treated (Kearney 2014, pers. comm.). As the volumes of the treated water added to the drilling mud system or water management system are not known, it is not possible to calculate the concentration of glutaraldehyde in each of the systems. However, estimates of glutaraldehyde in the drilling mud systems have been made below, using assumptions of volumes of treated water used.

Table 4: Volume of glutaraldehyde potentially added daily to drilling mud system depending on the amount of treated water used

	Units	**Volume of Glutaraldehyde based on the amount of treated water applied**			
Percentage of total water treatment daily applied to drilling mud system	%	99	95	90	80
Volume of Glutaraldehyde	L per day	54.7	52.5	49.8	44.2

3.2 M300A – Use in stimulation activities

The FDS provided the total volume of each fluid, individual chemical names/CAS numbers and mass fractions (%) of each component. These fluid components were divided into chemical additives, proppants and water, and the estimated mass of each fluid is summarised in Table 5. It was assumed that a proppant would be a solid at depth (e.g. ceramic material and silica). Due to the preparation method and injection protocols, it is assumed that concentrations reported in Table 5 would vary. However, a conservative estimate of additive masses was applied during the estimate.

The fluid disclosure sheets indicate that stimulations use 0.8 megalitres (ML). However, QGC indicated that the injected total volumes per well could range from 0.3 ML to 7 ML of fluid (Kearney 2015, pers. comm). Therefore, the mass of additives, proppant and water added per stimulation have also been calculated using the upper and lower range of inject total volumes (Table 5).

Table 5: Indicative Component Mass per Stimulation Stage

Fluid System	[redacted]	**Mass calculated using a range of injected total volumes per well**	
Typical fluid Volume[1]	~ 794 936 L	0.3 ML of fluid	7 ML of fluid
Additives	~ 8 649 kg (~ 1 %)	~ 3 243 kg	~ 75 680 kg
Glutaraldehyde	*~ 393 kg (~ 0.05 %)*	*~ 147 kg*	*~ 3 440 kg*
Proppant	~ 47 181 kg (~ 6 %)	~ 17 693 kg	~ 412 833 kg
Water*	~ 739 106 kg (~ 93 %)	~ 277 165 kg	~6 467 181 kg

Notes: ML – mega litres. Fluid volume for stimulation, as indicated in the service provider's FDR (not provided to maintain the confidentiality of commercially sensitive information). *Assuming that density of total typical fluid volume is 1 kg/L. [1]Mass of components are related to typical fluid volume density.

The hydraulic stimulation fluid comprises predominantly water (93%), with a secondary component consisting of proppant (6 %) and a minor fraction which consists of additives (1 %).

Following completion of the hydraulic stimulation process, a percentage fraction of the injected hydraulic stimulation fluids are recovered upon flowback and production of the well. However, it should be noted that most of the additives would have undergone chemical transformations in the sub-surface. In addition, the formation also contributes a certain amount of water and dissolved salts to the flowback and production of the well. If it is conservatively assumed that 20% of the hydraulic stimulation fluid volume remains in the formation (reasonable "worst case") this would correspond to approximately 1 730 kg (649 kg to 15 136 kg) of chemical additives (and ~79 kg (29 kg to 688 kg) of glutaraldehyde) per well, excluding proppant, depending on the fluid system used.

4.0 UNCERTAINTY ANALYSIS

The evaluation of the human health and ecological hazards of glutaraldehyde is limited by the quantity and quality of information available in the sources reviewed and the literature received by Golder from QGC. A measure of the data completeness across the toxicological and hazard parameters used has been estimated expressed as a percentage of the parameters for which data were available. These are presented in each summary in Appendix B and Appendix C.

An assessment of the quality of the available data is beyond the scope of this report. In the absence of such a review Golder has relied on primary literature sources from established, robust and reputable sources such as ECHA, NICNAS and US EPA where available. As new toxicological data are generated and become available in the published literature, the information presented in this hazard evaluation and the associated conclusions may be subject to change. On this basis the hazard profiles are dated to enable future review as may be appropriate. This is particularly pertinent across human health parameters within the highest Hazard Band category (4) which includes such areas as endocrine disruption potential and carcinogenicity.

5.0 EXCLUSIONS

This document provides a hazard assessment which reflects the potential concerns associated with the intrinsic toxicity of the substances reviewed. A hazard assessment does not include exposure assessment considerations that may or may not realise the expression of the hazards, however, comment is made to place exposures into perspective associated with fate and transport properties and specific physico-chemical properties, e.g. the residual nature of metals. A comprehensive exposure assessment and risk characterisation is available in the 21 February 2014 Golder report.

6.0 CONCLUSIONS

Table 6 and Table 7 summarise the outcomes of the human health and ecological toxicity reviews, respectively.

Table 6: Summary of Human Health Toxicity Hazard Band Ranking

Compound	Mass Fraction (wt.%)[1]	Human Health Hazard Band[2]	Comment
Glutaraldehyde	< 30%	3	Glutaraldehyde has been ranked in Hazard Band 3, based on it being identified as a respiratory sensitiser and corrosive to the skin and eyes.

Note: 1. Maximum percentage reported in Table 1; 2. A ranking of 0 represents the lowest toxicity and 4 represents the highest toxicity.

Table 7: Summary of Ecotoxicology Ranking

Compound	Mass Fraction (wt.%)[1]	Aquatic Toxicity	Comment	Terrestrial Toxicity	Comment
Glutaraldehyde	< 30%	moderate hazard	Based on both the toxicity data and the behaviour of glutaraldehyde in aquatic (freshwater) (likely rapid biodegradation in the aquatic environment)	moderate hazard	Based on both the toxicity data and the behaviour of glutaraldehyde in the terrestrial ecosystems (the rapid metabolism of glutaraldehyde in soil and that it does not tend to bioaccumulate).

Note: 1. Maximum percentage reported in Table 1

The overall conclusions of the *Human Health and Ecological Chemical Assessment – Hydraulic Stimulation Chemical Assessment – QGC Surat and Bowen Basin Operation* report (Golder, 21 February 2014) are not changed by the outcomes of this assessment.

7.0 IMPORTANT INFORMATION

Your attention is drawn to the document - “Important Information Relating to this Report”, which is included in Appendix D of this report. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be. The document is not intended to reduce the level of responsibility accepted by Golder, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

8.0 REFERENCES

ECHA (European Chemicals Agency) 2014. Registered Chemical Substances Search: *Dossier of Glutaraldehyde* Available at http://apps.echa.europa.eu/registered/data/dossiers/DISS-9da0a533-b0fd-2d22-e044-00144f67d249/AGGR-0632b981-76e6-4073-b5cc-aeb2a932c0b2_DISS-9da0a533-b0fd-2d22-e044-00144f67d249.html#L-ef58562b-723c-4283-b24d-22c998d8db48, Accessed December 2014

ECOSAR (Ecological Structure Activity Relationships) 2012. Ecological Structure Activity Relationships ECOSAR™ software version 1.11 dated July 2012. Available at: http://www.epa.gov/oppt/newchems/tools/21ecosar.htm, Accessed December 2014

EPISUITE, 2011. *United States Environmental Protection Agency Exposure Tools and Assessment EPISUITE v4.1*. Available at: http://www.epa.gov/oppt/exposure/pubs/episuitedl.htm, Accessed December 2014

HSDB (Hazardous Substances Data Bank), 2011. *Dossier for Glutaraldehyde*. TOXNET, US National Library of Medicine. Available at http://toxnet.nlm.nih.gov/ [Accessed December 2014]

Kearney, S 2014, Environmental Engineer, QGC, Brisbane, QLD, email to N Underhill (Golder) 5 December 2014.

Kearney, S 2015, Environmental Engineer, QGC, Brisbane, QLD, email to N Underhill (Golder) 15 January 2015.

Leung, H.W. 2001. Ecotoxicology of Glutaraldehyde: Review of Environmental Fate and Effects Studies. Ecotoxicology and Environmental Safety 49: 26-39.

NICNAS (National Industrial Chemicals Notification and Assessment Scheme) 1994, *Priority Existing Chemical Assessment Report No.3 – Glutaraldehyde.*

Report Signature Page

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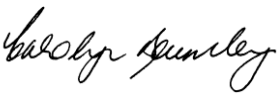

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APPENDIX A

Product Information

HALLIBURTON | Baroid

ALDACIDE® G

Biocide — Product Data Sheet

Product Description

ALDACIDE® G biocide is suitable for use in water based drilling fluids and packer fluids. ALDACIDE G biocide is effective against aerobic and anaerobic bacteria and is compatible with all brine types. Use of ALDACIDE G biocide in conjunction with sulphite oxygen scavengers is not recommended.

Applications / Functions

- Prevent spoilage of organic colloids
- Control sulfate reducing bacteria

Advantages

- Environmentally responsible
- Effective in small concentrations
- Compatible with most water-based drilling fluids

Typical Properties

• Appearance	Transparent liquid
• Specific gravity	1.06

Recommended Treatment

Add 0.2-0.5 lb/bbl (0.57-1.43 kg/m³) of ALDACIDE G biocide directly to the circulating system.

Warning: ALDACIDE G biocide is incompatible with BARASCAV™ D oxygen scavenger and BARASCAV L oxygen scavenger.

Packaging

ALDACIDE G biocide is packaged in 5-gal (18.9-l) pails and 55-gal (208-l) drums.

www.halliburton.com/baroid

3/24/2010

HALLIBURTON

MATERIAL SAFETY DATA SHEET

Product Trade Name: **ALDACIDE® G ANTIMICROBIAL**

Revision Date: 17-Aug-2012

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/UNDERTAKING

Statement of Hazardous Nature Hazardous according to the criteria of NOHSC, Non-Dangerous Goods according to the criteria of ADG.

Manufacturer/Supplier

Halliburton Australia Pty. Ltd.
15 Marriott Road
Jandakot
WA 6164
Australia

ACN Number: 009 000 775
Telephone Number: 61 (08) 9455 8300
Fax Number: 61 (08) 9455 5300

Product Emergency Telephone
Australia: 08-64244950
Papua New Guinea: 05 1 281 575 5000
NewZealand: 06-7559274

Fire, Police & Ambulance - Emergency Telephone
Australia: 000
Papua New Guinea: 000
New Zealand: 111

Identification of Substances or Preparation

Product Trade Name: ALDACIDE® G ANTIMICROBIAL
Synonyms: None
Chemical Family: Aldehyde
UN Number: , UN3265
Dangerous Goods Class: None
Subsidiary Risk: None
Hazchem Code: None Allocated
Poisons Schedule: S6
Application: Biocide

Prepared By

Chemical Compliance
Telephone: 1-580-251-4335
e-mail: fdunexchem@halliburton.com

2. COMPOSITION/INFORMATION ON INGREDIENTS

Substances	CAS Number	PERCENT	Australia NOHSC	New Zealand WES	ACGIH TLV-TWA
Glutaraldehyde	111-30-8	10 - 30%	0.1 ppm	STEL: 0.05 ppm	0.05 ppm

Non-Hazardous Substance to Total of 100%

3. HAZARDS IDENTIFICATION

Hazard Overview

Keep out of reach of children. May cause eye burns. May cause irreversible eye damage. May cause severe skin irritation. May be harmful if swallowed. May be harmful if inhaled. May cause allergic skin reaction.

Risk Phrases

R34 Causes burns.
R20/22 Harmful by inhalation and if swallowed.
R42/43 May cause sensitization by inhalation and skin contact.

HSNO Classification

Not Determined

4. FIRST AID MEASURES

Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Skin

In case of contact, immediately flush skin with plenty of soap and water for at least 15 minutes. Get medical attention. Remove contaminated clothing and discard.

Eyes

Immediately flush eyes with large amounts of water for at least 30 minutes. Seek prompt medical attention.

Ingestion

Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.

Notes to Physician

Probable mucosal damage may contraindicate the use of gastric lavage. No specific antidote. Treat symptomatically.

5. FIRE FIGHTING MEASURES

Suitable Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

Extinguishing media which must not be used for safety reasons

None known.

Special Exposure Hazards

Decomposition in fire may produce toxic gases.

Special Protective Equipment for Fire-Fighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. ACCIDENTAL RELEASE MEASURES

Personal Precautionary Measures

Use appropriate protective equipment. Use only competent persons for cleanup.

Environmental Precautionary Measures

Prevent from entering sewers, waterways, or low areas.

Procedure for Cleaning / Absorption

Isolate spill and stop leak where safe. Contain spill with sand or other inert materials. Scoop up and remove.

7. HANDLING AND STORAGE

Handling Precautions Avoid contact with eyes, skin, or clothing. Avoid breathing vapors. Avoid breathing mist. Do not swallow. Wash hands after use. Launder contaminated clothing before reuse.

Storage Information Store away from acids. Store away from alkalis. Keep container closed when not in use. Product has a shelf life of 12 months.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls Use in a well ventilated area. Local exhaust ventilation should be used in areas without good cross ventilation. If vapors are strong enough to be irritating to the nose or eyes, the TLV is probably being exceeded and special ventilation or respiratory protection maybe required.

Respiratory Protection Full Facepiece Respirator with Organic vapor cartridge with particulate prefilter.

Hand Protection Nitrile gloves. Butyl rubber gloves.

Skin Protection Butyl coated apron or clothing.

Eye Protection Splashproof chemical monogoggles or safety glasses with side shields in conjunction with a face shield. Do NOT wear contact lenses.

Other Precautions Eyewash fountains and safety showers must be easily accessible.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Liquid
Color:	Clear light yellow
Odor:	Sharp
pH:	3.1-4.5
Specific Gravity @ 20 C (Water=1):	1.064
Density @ 20 C (kg/l):	1.064
Bulk Density @ 20 C (kg/m^3):	Not Determined
Boiling Point/Range (C):	100.5
Freezing Point/Range (C):	-5 / -10
Pour Point/Range (C):	Not Determined
Flash Point/Range (C):	Not Determined
Flash Point Method:	Not Determined
Autoignition Temperature (C):	> 275
Flammability Limits in Air - Lower (g/m^3):	Not Determined
Flammability Limits in Air - Lower (%):	Not Determined
Flammability Limits in Air - Upper (g/m^3):	Not Determined
Flammability Limits in Air - Upper (%):	Not Determined
Vapor Pressure @ 20 C (mmHg):	0.2
Vapor Density (Air=1):	0.8
Percent Volatiles:	100
Evaporation Rate (Butyl Acetate=1):	0.9
Solubility in Water (g/100ml):	Soluble
Solubility in Solvents (g/100ml):	Not Determined
VOCs (g/l):	Not Determined
Viscosity, Dynamic @ 20 C (centipoise):	Not Determined
Viscosity, Kinematic @ 20 C (centistokes):	Not Determined
Partition Coefficient/n-Octanol/Water:	-0.333
Molecular Weight (g/mole):	Not Determined
Decomposition Temperature (C):	Not Determined

10. STABILITY AND REACTIVITY

Stability Data: Stable

Hazardous Polymerization: Will Not Occur

Conditions to Avoid Keep away from heat, sparks and flame.

Incompatibility (Materials to Avoid) Strong acids. Strong alkalis.

Hazardous Decomposition Products Carbon monoxide and carbon dioxide.

Additional Guidelines Not Applicable

11. TOXICOLOGICAL INFORMATION

Principle Route of Exposure Eye or skin contact, inhalation.

Sympotoms related to exposure

Inhalation Harmful if inhaled. Causes severe respiratory irritation. Vapors given off by heated product may be harmful. May cause allergic respiratory reaction. Inhalation of vapors may result in skin sensitization.

Skin Contact May cause skin burns. This product contains ingredients which may produce an allergic skin reaction. It should be treated as a skin sensitizer.

Eye Contact May cause eye burns. May cause permanent eye damage. High vapor concentration will cause irritation.

Ingestion Causes burns of the mouth, throat and stomach. Harmful if swallowed. Aspiration into the lungs may cause chemical pneumonitis including coughing, difficulty breathing, wheezing, coughing up blood and pneumonia, which can be fatal.

Aggravated Medical Conditions Skin disorders. Lung disorders. Liver disorders.

Chronic Effects/Carcinogenicity No data available to indicate product or components present at greater than 1% are chronic health hazards.

Other Information None known.

Toxicity Tests

Oral Toxicity: LD50: 320 mg/kg (Rat)

Dermal Toxicity: LD50: > 2000 mg/kg (Rabbit)

Inhalation Toxicity: LC50: 0.28-0.39 mg/l/4 hr (Rat)

Primary Irritation Effect: Not determined

Carcinogenicity Not determined

Genotoxicity: Not determined

Reproductive / Developmental Toxicity: Not determined

12. ECOLOGICAL INFORMATION

Mobility (Water/Soil/Air) Not determined

Persistence/Degradability Readily biodegradable

Bio-accumulation Not expected to bioaccumulate.

Ecotoxicological Information

Acute Fish Toxicity: May be highly toxic to aquatic life.
LC50: (96 hour) 13 mg/l (Lepomis macrochirus)

Acute Crustaceans Toxicity: TLM48: 0.11 mg/l (Acartia tonsa)
TLM48: 29.73 mg/l (Daphnia magna)

Acute Algae Toxicity: EC50: 8.1 mg/l (Skeletonema costatum)

Chemical Fate Information Not determined

Other Information Not applicable

13. DISPOSAL CONSIDERATIONS

Disposal Method Disposal should be made in accordance with federal, state, and local regulations.

Contaminated Packaging Follow all applicable national or local regulations.

14. TRANSPORT INFORMATION

Land Transportation

ADR

UN3265,Corrosive Liquid, Acidic, Organic, N.O.S.(Contains Glutaraldehyde), 8, III

Air Transportation

ICAO/IATA

UN3265,Corrosive Liquid, Acidic, Organic, N.O.S., 8, III
(Contains Glutaraldehyde)

Sea Transportation

IMDG

UN3265,Corrosive Liquid, Acidic, Organic, N.O.S.(Contains Glutaraldehyde), 8, III
EmS F-A, S-B

Other Transportation Information

Labels: Corrosive

15. REGULATORY INFORMATION

Chemical Inventories

Australian AICS Inventory All components listed on inventory or are exempt.
New Zealand Inventory of Chemicals This product does not comply with NZIOC

US TSCA Inventory	All components listed on inventory or are exempt.
EINECS Inventory	This product, and all its components, complies with EINECS
Classification	C - Corrosive.
Risk Phrases	R34 Causes burns. R20/22 Harmful by inhalation and if swallowed. R42/43 May cause sensitization by inhalation and skin contact.
Safety Phrases	S23 Do not breathe gas, fumes, vapour or spray. S26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. S45 In case of accident or if you feel unwell, seek medical advice immediately. S1/2 Keep locked up and out of reach of children. S36/37/39 Wear suitable protective clothing, gloves and eye/face protection.

16. OTHER INFORMATION

The following sections have been revised since the last issue of this SDS
Not applicable

Contact

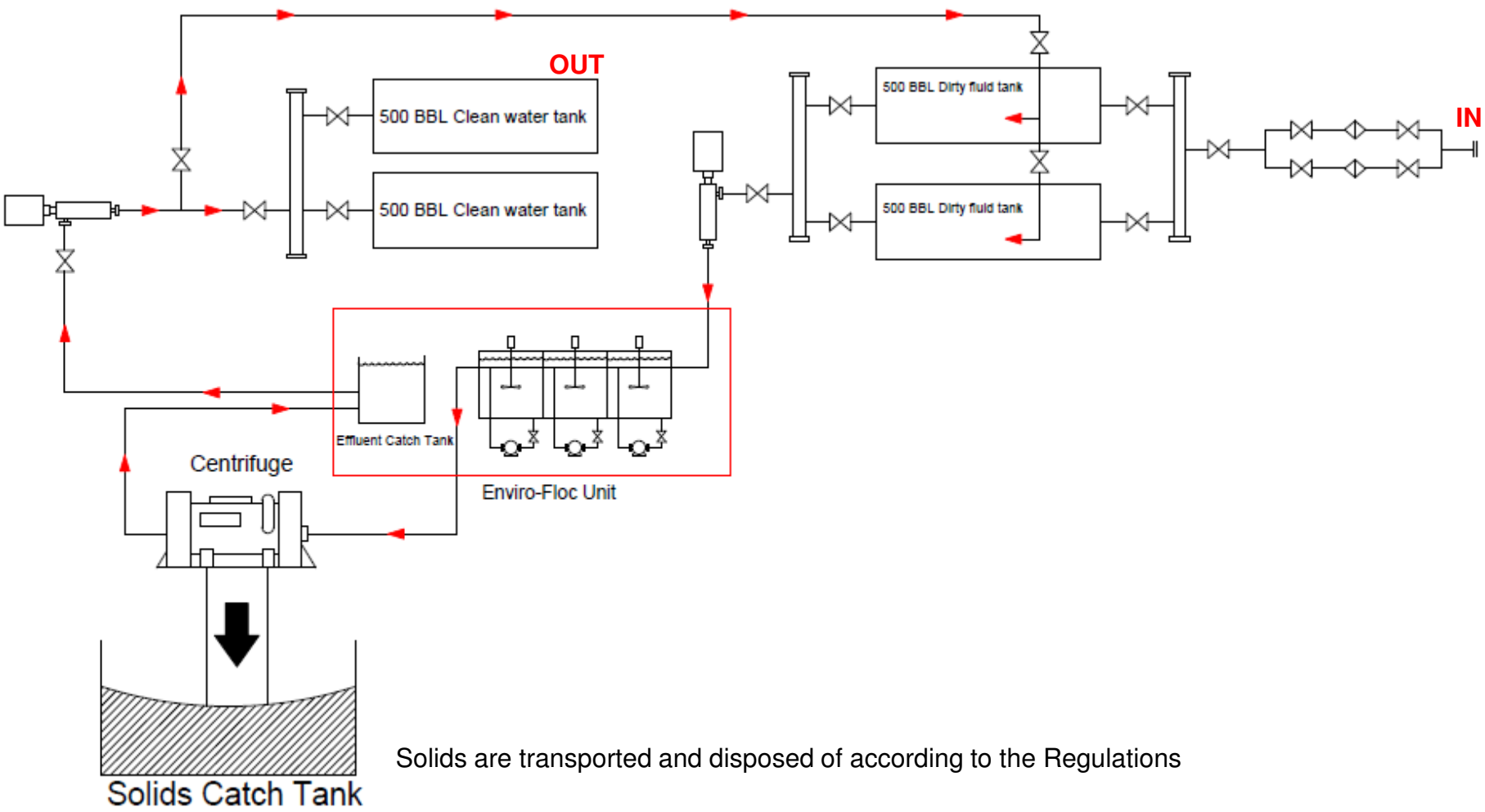
Australian Poisons Information Centre
24 Hour Service: - 13 11 26
Police or Fire Brigade: - 000 (exchange): - 1100

New Zealand National Poisons Centre
0800 764 766

Additional Information	For additional information on the use of this product, contact your local Halliburton representative. For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Compliance at 1-580-251-4335.
Disclaimer Statement	This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

*****END OF MSDS*****

Dewatering Operations



Solids are transported and disposed of according to the Regulations

Enviro-Floc System

Safety data sheet

1. Substance/preparation and company identification

Protectol® GA 24

Use: biocide

Manufacturer/supplier:
BASF Australia Limited (ABN 62 008 437 867)
Level 12, 28 Freshwater Place Southbank
Victoria 3006, AUSTRALIA
Telephone: +61 3 8855-6600
Telefax number: +61 3 8855-6511

Emergency information:
BASF Emergency Advice Number: 1800 803 440 (24h) [within Australia]
BASF Emergency Advice Number: + 61 3 8855 6666 [outside Australia]

2. Hazard identification

HAZARDOUS SUBSTANCE, DANGEROUS GOOD
Causes burns.
Harmful by inhalation and if swallowed.
May cause sensitization by inhalation and skin contact.

Wear suitable protective clothing and gloves.
Do not breathe spray.
In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
After contact with skin, wash immediately with plenty of water.
In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
If swallowed, do not induce vomiting: seek medical advice immediately and show this container or label.

3. Composition/information on ingredients

Chemical nature

dialdehydes, glutaral (Content (W/W): 24 %), water (Content (W/W): 76 %)

Hazardous ingredients

glutaral

Content (W/W): >= 20 % - < 25 %
CAS Number: 111-30-8
Hazard symbol(s): T, N
R-phrase(s): 23/25, 34, 42/43, 50

The wording of the hazard symbols and R-phrases is specified in section 16 if dangerous ingredients are mentioned.

4. First-Aid Measures

General advice:
Immediately remove contaminated clothing. If danger of loss of consciousness, place patient in recovery position and transport accordingly. Apply artificial respiration if necessary. First aid personnel should pay attention to their own safety.

If inhaled:
Keep patient calm, remove to fresh air, seek medical attention. Immediately administer a corticosteroid from a controlled/metered dose inhaler.

On skin contact:
Immediately wash thoroughly with plenty of water, apply sterile dressings, consult a skin specialist.

On contact with eyes:
Immediately wash affected eyes for at least 15 minutes under running water with eyelids held open, consult an eye specialist.

On ingestion:
Immediately rinse mouth and then drink 200-300 ml of water, seek medical attention.

Note to physician:
Symptoms: The most important known symptoms and effects are described in the labelling (see section 2) and/or in section 11., Further symptoms are possible
Treatment: Treat according to symptoms (decontamination, vital functions), no known specific antidote.

5. Fire-Fighting Measures

Suitable extinguishing media:
water spray, dry powder, carbon dioxide

Specific hazards:
nitrogen oxides, carbon oxides
The substances/groups of substances mentioned can be released in case of fire.

Special protective equipment:
Wear self-contained breathing apparatus and chemical-protective clothing.

Further information:
Dispose of fire debris and contaminated extinguishing water in accordance with official regulations.

6. Accidental Release Measures

Personal precautions:
Avoid inhalation. Avoid contact with the skin, eyes and clothing.

Environmental precautions:
Do not discharge into drains/surface waters/groundwater.

Methods for cleaning up or taking up:
For large amounts: Pump off product.
For residues: Pick up with suitable absorbent material (e.g. sand, sawdust, general-purpose binder, kieselguhr). Dispose of absorbed material in accordance with regulations.

7. Handling and Storage

Handling

Ensure thorough ventilation of stores and work areas. Avoid aerosol formation.

Protection against fire and explosion:
Prevent electrostatic charge - sources of ignition should be kept well clear - fire extinguishers should be kept handy.

Storage

Further information on storage conditions: Keep container tightly closed in a cool, well-ventilated place.
Keep under inert gas.

Storage stability:
Storage temperature: <= 25 °C
Storage duration: 12 Months
From the data on storage duration in this safety data sheet no agreed statement regarding the warrantee of application properties can be deduced.

8. Exposure controls and personal protection

Components with occupational exposure limits

glutaral, 111-30-8;

Peak limitation 0.41 mg/m3 ; 0.1 ppm (OEL (AU))

Personal protective equipment

Respiratory protection:
Breathing protection if gases/vapours are formed. Gas filter for gases/vapours of organic compounds (boiling point >65 °C, e. g. EN 14387 Type A) Respiratory protection in case of vapour/aerosol release. Combination filter for gases/vapours of organic compounds and solid and liquid particles (f.e. EN 14387 Type A-P2)

Hand protection:
Chemical resistant protective gloves (EN 374)
Suitable materials also with prolonged, direct contact (Recommended: Protective index 6, corresponding > 480 minutes of permeation time according to EN 374):
butyl rubber (butyl) - 0.7 mm coating thickness
nitrile rubber (NBR) - 0.4 mm coating thickness
Manufacturer's directions for use should be observed because of great diversity of types.
Supplementary note: The specifications are based on tests, literature data and information of glove manufacturers or are derived from similar substances by analogy. Due to many conditions (e.g. temperature) it must be considered, that the practical usage of a chemical-protective glove in practice may be much shorter than the permeation time determined through testing.

Eye protection:
Tightly fitting safety goggles (cage goggles) (e.g. EN 166) and face shield.

Body protection:
Body protection must be chosen depending on activity and possible exposure, e.g. apron, protecting boots, chemical-protection suit (according to EN 14605 in case of splashes or EN ISO 13982 in case of dust).

General safety and hygiene measures:
Avoid contact with the skin, eyes and clothing. Do not breathe vapour/spray. Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is required additionally to the stated personal protection equipment.

9. Physical and Chemical Properties

Form:	liquid	
Colour:	colourless to yellowish	
Odour:	pungent odour	
pH value:	3.7 (50 %(m), 23 °C)	(other)
	5.9 (water, 0.5 %(m), 23 °C)	(other)
Melting point:	-5 °C	
Boiling point:	101.5 °C (987.1 hPa)	(other)

Information on: glutaral		
Flash point:	95 °C (50 %(m)) No flash point - Measurement made up to the indicated temperature, pilot light extinguishes.	(closed cup)
---	---	---
Flammability:	not flammable	(other)
Lower explosion limit:	For liquids not relevant for classification and labelling.	
Upper explosion limit:	For liquids not relevant for classification and labelling.	
Information on: glutaral		
Ignition temperature:	395 °C (50 %(m))	(Directive 92/69/EEC, A.15)
---	---	---
Self ignition:	not self-igniting	Test type: Spontaneous self-ignition at room-temperature. (Method: other)
Explosion hazard:	not explosive	(Directive 92/69/EEC, A.14)
Fire promoting properties:	Based on its structural properties the product is not classified as oxidizing.	(other)
Vapour pressure:	20 hPa (20.1 °C)	(measured)
Density:	1.0648 g/cm3 (20 °C)	(pyknometer)
Solubility in water:	miscible (20.2 °C)	
Partitioning coefficient n-octanol/water (log Pow):	-0.36 (23 °C; pH value: 7)	(Directive 92/69/EEC, A.8)
Information on: glutaral		
Adsorption/water - soil:	log KOC: 0.76	(other)
---	---	---
Surface tension:	68 mN/m (20 °C; 1 g/l)	(OECD-Guideline 115)
Viscosity, kinematic:	12.75 mm2/s (25 °C)	
Molar mass:	100.12 g/mol	

10. Stability and Reactivity

Conditions to avoid:
Avoid all sources of ignition: heat, sparks, open flame. See MSDS section 7 - Handling and storage.

Thermal decomposition:	< 110 °C No exothermic decomposition within the mentioned temperature range. No decomposition if used as directed. It is not a self-decompositionable substance.

Substances to avoid:
amines

Corrosion to metals: Corrosive effect on metals.

Hazardous reactions:
Reacts with amines. The progress of reaction is exothermic.

Hazardous decomposition products:
carbon oxides

11. Toxicological Information

Acute toxicity

Information on: glutaral
Assessment of acute toxicity:
Of high toxicity after single ingestion. Of high toxicity after short-term inhalation. Of low toxicity after short-term skin contact.

Information on: glutaral
LD50 rat (oral): approx. 158 mg/kg (OECD Guideline 401)

Information on: glutaral
LC50 rat (by inhalation): 0.28 - 0.39 mg/l 4 h (similar to OECD guideline 403)
An aerosol was tested.

LC100 rat (by inhalation): 15 mg/l 7 h (IRT)
The vapour was tested.

Information on: glutaral
LD50 rat (dermal): > 1,000 mg/kg (OECD Guideline 402)
The data on toxicology refer to the active ingredient. The value meets the highest applied test concentration.

LD50 rabbit (dermal): > 1,000 mg/kg (similar to OECD guideline 402)
No mortality was observed. The data on toxicology refer to the active ingredient. The value meets the highest applied test concentration.

Irritation

Information on: glutaral
Assessment of irritating effects:

Corrosive! Damages skin and eyes.

Information on: glutaral
Primary skin irritation rabbit: Corrosive. (OECD Guideline 404)

Information on: glutaral
Primary irritations of the mucous membrane rabbit: Risk of serious damage to eyes. (Draize test)

Assessment other acute effects

Assessment other acute effects:
Based on the available information there is no specific target organ toxicity to be expected after a single exposure.

Remarks: The product has not been tested. The statement has been derived from the properties of the individual components.

Sensitization

Information on: glutaral
Assessment of sensitization:
Sensitization after skin contact possible. The substance may cause sensitization of the respiratory tract.

Information on: glutaral
Open epicutaneous test (OET) guinea pig: sensitizing

human: sensitizing

Genetic toxicity

Information on: glutaral
Assessment of mutagenicity:
The substance was mutagenic in various test systems with bacterias and cell cultures; however, these results could not be confirmed in tests with mammals.

Carcinogenicity

Information on: glutaral
Assessment of carcinogenicity:
In long-term animal studies in which the substance was given in the drinking water in high concentrations, a carcinogenic effect was not observed. In long-term animal studies in which the substance was given by inhalation, a carcinogenic effect was not observed.

Reproductive toxicity

Information on: glutaral

Assessment of reproduction toxicity:
The results of animal studies gave no indication of a fertility impairing effect.

Developmental toxicity

Information on: glutaral
Assessment of teratogenicity:
No indications of a developmental toxic / teratogenic effect were seen in animal studies.
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12. Ecological Information

Ecotoxicity

Assessment of aquatic toxicity:
There is a high probability that the product is not acutely harmful to aquatic organisms. The product has not been tested. The ecological data given are those of the active ingredient.

Information on: glutaral
Toxicity to fish:
LC50 (96 h) 39 mg/l, Cyprinodon variegatus (Fish test acute, static)
The details of the toxic effect relate to the nominal concentration.

LC50 (96 h) 9.4 mg/l, Lepomis macrochirus (Fish test acute, static)
The details of the toxic effect relate to the nominal concentration.

Information on: glutaral
Aquatic invertebrates:
EC50 (48 h) 5.75 mg/l, Daphnia magna (Daphnia test acute, static)
The details of the toxic effect relate to the nominal concentration.

EC50 (96 h) 0.75 mg/l, Crassatrea virginica (other, Flow through.)
The statement of the toxic effect relates to the analytically determined concentration.

LC50 (96 h) 5.5 mg/l, Mysidopsis bahia (OPP 72-3 (EPA-Guideline), Flow through.)
The statement of the toxic effect relates to the analytically determined concentration.

Information on: glutaral
Aquatic plants:
EC50 (72 h) 0.6 mg/l (growth rate), Desmodesmus subspicatus (OECD Guideline 201, static)
The statement of the toxic effect relates to the analytically determined concentration.

No observed effect concentration (72 h) 0.025 mg/l, Desmodesmus subspicatus (OECD Guideline 201, static)
The statement of the toxic effect relates to the analytically determined concentration.

EC50 (72 h) 0.92 mg/l (growth rate), Skeletonema costatum (ISO/DIS 10253)
The details of the toxic effect relate to the nominal concentration.

Information on: glutaral
Microorganisms/Effect on activated sludge:
EC20 (30 min) approx. 15 mg/l, activated sludge, domestic (OECD Guideline 209, aerobic)
The details of the toxic effect relate to the nominal concentration.

Mobility

Information on: glutaral
Assessment transport between environmental compartments:
The substance will not evaporate into the atmosphere from the water surface.
Adsorption to solid soil phase is possible.

Persistence and degradability

Information on: glutaral
Assessment biodegradation and elimination (H2O):
Readily biodegradable (according to OECD criteria).

Information on: glutaral
Elimination information:
90 - 100 % DOC reduction (28 d) (OECD 301 A (new version)) (aerobic, activated sludge, domestic)

Information on: glutaral
Assessment of stability in water:
In contact with water the substance will hydrolyse slowly.

Sum parameter

Theoretical Oxygen Demand (ThOD): (calculated) 460.3 mg/g

Bioaccumulation potential

Bioaccumulation potential:
Because of the n-octanol/water distribution coefficient (log Pow) accumulation in organisms is not to be expected.

Information on: glutaral
Assessment bioaccumulation potential:
No significant accumulation in organisms is expected as a result of the distribution coefficient of n-octanol/water (log Pow).

Additional information

Other ecotoxicological advice:
Data refer to a diluted aqueous solution of the substance.

13. Disposal Considerations

Incinerate in suitable incineration plant, observing local authority regulations.

A waste code in accordance with the European waste catalog (EWC) cannot be specified, due to dependence on the usage.
The waste code in accordance with the European waste catalog (EWC) must be specified in cooperation with disposal agency/manufacturer/authorities.

Contaminated packaging:
Contaminated packaging should be emptied as far as possible; then it can be passed on for recycling after being thoroughly cleaned.

14. Transport Information

Domestic transport:

Hazard class:	8
Packing group:	II
ID number:	UN 3265
Hazard label:	8
Proper shipping name:	CORROSIVE LIQUID, ACIDIC, ORGANIC, N.O.S. (contains GLUTARALDEHYDE)

Further information
Hazchem Code:2X
IERG Number:36

Sea transport
IMDG

Hazard class:	8
Packing group:	II
ID number:	UN 3265
Hazard label:	8
Marine pollutant:	NO
Proper shipping name:	CORROSIVE LIQUID, ACIDIC, ORGANIC, N.O.S. (contains GLUTARALDEHYDE)

Air transport
IATA/ICAO

Hazard class:	8
Packing group:	II
ID number:	UN 3265
Hazard label:	8
Proper shipping name:	CORROSIVE LIQUID, ACIDIC, ORGANIC, N.O.S. (contains GLUTARALDEHYDE)

15. Regulatory Information

Poisons Schedule: Not scheduled

Regulations of the European union (Labelling)

Directive 1999/45/EC ('Preparation Directive'):

Hazard symbol(s)

C	Corrosive.

R-phrase(s)

R34	Causes burns.
R20/22	Harmful by inhalation and if swallowed.
R42/43	May cause sensitization by inhalation and skin contact.

S-phrase(s)

S36/37	Wear suitable protective clothing and gloves.
S23.1	Do not breathe spray.
S26	In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S28.2	After contact with skin, wash immediately with plenty of water.
S45	In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
S62	If swallowed, do not induce vomiting: seek medical advice immediately and show this container or label.

Classification according to the calculation method of the directive for preparations (1999/45/EC).

Hazard determining component(s) for labelling: GLUTARALDEHYDE

Other regulations

Registration status:

AICS, AU	released / listed

16. Other Information

Must not be used in spray form.

Full text of hazard symbols and R-phrases if mentioned as hazardous components in section 3:

T	Toxic.
N	Dangerous for the environment.
23/25	Toxic by inhalation and if swallowed.
34	Causes burns.
42/43	May cause sensitization by inhalation and skin contact.

50	Very toxic to aquatic organisms.

Vertical lines in the left hand margin indicate an amendment from the previous version.

The data contained in this safety data sheet are based on our current knowledge and experience and describe the product only with regard to safety requirements. The data do not describe the product's properties (product specification). Neither should any agreed property nor the suitability of the product for any specific purpose be deduced from the data contained in the safety data sheet. It is the responsibility of the recipient of the product to ensure any proprietary rights and existing laws and legislation are observed.

APPENDIX B

Human Health Chemical Profiles

Project number: 127635006
Project name: Biocide Assessment, Southwest Queensland
Client name: QGC

Name	Glutaraldehyde
Synonyms	Glutaral; 1,5-pentanedial Pentanedial; 1,5-pentanedione; 1,3-diformylpropane; Glutaric dialdehyde; Glutaral Glutardialdehyde; Potentiated Acid Glutaraldehyde
CAS number	111-30-8
Molecular formula	$C_5H_8O_2$
Molecular Structure	

Overview	References
Glutaraldehyde is a colourless oily liquid which has a variety of uses. In Australia, it's primarily used as a cold disinfectant by the health care industry. Other uses include as a hardener in x-ray film processing, as a fixative in tanning, as a disinfectant of animal housing, aircraft and portable toilets, as a preservative in industrial oils and as a biocide in aquaculture. Glutaraldehyde is primarily used as an aqueous solution, ranging in concentration from 50% w/w to less than 1% w/w. It is not manufactured as a pure chemical in Australia (based on the National Industrial Chemicals Notification and Assessment Scheme (NICNAS) (1994) review) but is imported by a number of companies (usually as a 25, 45 or 50 % w/w aqueous solution).	NICNAS 1994
Glutaraldehyde was declared a Priority Existing Chemical (PEC) in 1993 under the *Industrial Chemicals (Notification and Assessment) Act, 1989* due to adverse health concerns, which could results from individuals being exposed through the production, handling, use and disposal of glutaraldehyde. Occupational exposure to glutaraldehyde has resulted in occupational asthma, significant skin, respirator and eye irritation, as well as skin sensitisation in some cases.	
The Hazardous Substances Information System (HSIS) provided by Safe Work Australia, lists the following risk phrases for solutions of glutaraldehyde at 25 to 50 % concentration; T (Toxic); R23 (Toxic by inhalation); R22 (Harmful if swallowed); R34 (Causes burns); R42 (May cause sensitisation by inhalation) R43 (may cause sensitisation by skin contact).	Safe Work Australia 2014

Human Health Toxicity Summary	Reference
Carcinogenicity Glutaraldehyde has not been evaluated by the International Agency for Research on Cancer (IARC) as to its carcinogenicity.	IARC 2014
Glutaraldehyde is not classified as carcinogenic by ECHA (ECHA states conclusive data has been reviewed, indicating low toxicity which doesn't support classification under the GHS (Rev3)). ECHA presents a 2 year oral feeding study of rats which reported that neoplastic findings were spontaneous in origin and showed no treatment-relationship. The animals were fed glutaraldehyde (in water) daily ranging from 6.1 mg/kg bw/day to 176.4 mg/kg bw/day.	ECHA 2014 OECD SIDS 2005
In a second 2 years drinking water study rats receiving daily glutaraldehyde in water (between 4 mg/kg bw/day and 86 mg/kg bw/day) reported that overall there was a statistically significant increased incidence of large granular lymphocytic leukaemia (LGLL) in the liver and spleen only in female rats in both dose groups The finding was not conclusive as the strain of rats used in the study has a high natural susceptibility to LGLL and variation in control data existed within the	

study laboratory.	
Mutagenicity/Genotoxicity Glutaraldehyde is not classified as a mutagen by ECHA (ECHA states conclusive data has been reviewed, indicating low toxicity which doesn't support classification under the GHS (Rev3)). An in vivo cytogenicity study indicates that for rats who received 200 mg/kg bw or 400 mg/kg bw glutaraldehyde by oral gavage, the test were negative for genotoxicity. However, studies have indicated the glutaraldehyde is mutagenic in bacterial assays (in vitro studies).	ECHA 2014 ECHA 2014
Reproductive Toxicity Glutaraldehyde is not classified as reproductive toxicant (ECHA states conclusive data has been reviewed, indicating low toxicity which doesn't support classification under the GHS (Rev3). A summary of a reproductive study states a NOEL of 68 mg/kg bw/day for embryotoxicty. This was the highest dose group. Female rats were exposed to glutaraldehyde in their drinking water from day 6 to day 16 of gestation. Another similar study lists a LOAEL for maternal toxicity of 51 mg/kg bw/day (highest dose tested) based on reduction in food and water consumption and on the presence of foci in the glandular stomach of 2 animals.	ECHA 2014
Developmental Toxicity/Teratogenicity Glutaraldehyde is not classified as a developmental toxicant by ECHA (ECHA states conclusive data has been reviewed, indicating low toxicity which doesn't support classification under the GHS (Rev3). Two studies cited by ECHA indicated there was no evidence of teratogenicity in female rats fed glutaraldehyde in water during gestation. The highest dose was 68 mg/kg bw/day.	ECHA 2014
Endocrine Disruption Glutaraldehyde is not identified in the European Commission (EC)'s report, "*Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption*" as a substance of interest.	EC 2000
Acute Toxicity (oral, dermal, inhalation) Glutaraldehyde is classified as acutely toxic via the oral and inhalation route by ECHA based on its classification thresholds. *Oral* ECHA cites a study which reports an oral LD_{50} for rats of ~316 mg/kg bw for male and females. The LD_{50} is based on cumulative mortality after 14 days of observation of 10% at 215 mg/kg bw, 60% at 316 mg/kg bw and 90% at 464 mg/kg bw. The study was carried out in general accordance to OECD Guideline 401 (Acute Oral Toxicity). The glutaraldehyde was administered orally (by gavage). Other clinical signs of toxicity were seen in all treated groups and included poor general state, irregular breathing, apathy, piloerection, staggering, trembling and dehydration. *Inhalation* ECHA cites a study which reports an inhalation LC_{50} of 0.48 mg/ L air (480 mg/m^3) for male and female rats. The test was conducted in general accordance with OECD Guidelines 403 (Acute Inhalation Toxicity). The exposure duration was 4 hours and the rats were exposed to the test substance as liquid aerosol at the following nominal concentrations: 0.35, 0.58 and 0.72 mg/L. *Dermal* ECHA cites a study which reports a dermal LD_{50} of > 2000 mg/kg bw for male and female rabbits. Glutaraldehyde was applied semiocclusively at the one dose and the exposure period was 24 hours. Animals were observed for mortality, body weights, clinical signs or toxicity and local skin changes for 14 days after exposure. Limited clinical signs of mucoid faeces and wet brown	ECHA 2014

urogenital staining were observed in the first 3 days of observation. Necropsy revealed thickening and scabbing of the application sites in all animals. No further treatment-related abnormalities were reported.	
Chronic/repeat dose toxicity (oral, dermal, inhalation) Glutaraldehyde is not classified based on serious effects to organ systems following repeat dose exposure by the oral, dermal or inhalation route. (ECHA states conclusive data has been reviewed, indicating low toxicity which doesn't support classification under the GHS (Rev3). ECHA presents a 2 year oral feeding study of rats which reported that non-neoplastic findings clearly identified the larynx, the trachea, the lung and bronchi, the nasal cavity and the glandular stomach as target organs for glutaraldehyde in rats. A NOAEL of 100 ppm was established (corresponding to approximately 7 mg/kg bw/day for males and approximately 10 mg/kg bw/day in females).	ECHA 2014
Sensitisation of the skin or respiratory system Animal studies of respiratory sensitisation are not available. However, several studies have indicated occupational asthma and/or rhinitis have been linked with exposure to glutaraldehyde in the workplace. Glutaraldehyde is classified as potentially causing an allergic skin reaction by ECHA based on its classification thresholds. A study listed by ECHA reports that repeated induction treatment with the undiluted glutaraldehyde caused necrotic skin lesions with thick bloody crusts in all animals (guinea pigs). Following this, challenge treatment of the opposite flank with the undiluted glutaraldehyde, performed after 11 days without treatment, all animal exhibited slight erythema. Glutaraldehyde is classified as potentially causing allergy or asthma symptoms or breathing difficulties if inhaled.	ECHA 2014 ECHA 2014 Safe Work Australia 2014
Corrosion (irreversible)/irritation (reversible) effects on the skin or eye Glutaraldehyde is classified as causing severe skin burns and eye damage by EHCA based on its classification thresholds. A skin corrosion/irritation study of white rabbits was presented by ECHA, which reported erythema and oedema were observed after occlusive application of undiluted glutaraldehyde. The effects were observed to not be reversible. ECHA provides a study which found that glutaraldehyde was found to cause eye damage which was not reversible. 0.1 mL of the test substance (~50% glutaraldehyde) was applied into the conjunctival sac of the right eye and the rabbits were observed for 8 days.	ECHA 2014

Physical Hazards	Reference
Flammable Potential Not considered flammable by ECHA	ECHA 2014
Explosive Potential Not considered explosive by ECHA	ECHA 2014

Toxicity Values	Value	Reference
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	316 mg/kg bw	ECHA 2014
Rat, dermal	> 2000 mg/kg bw	ECHA 2014
LC_{50}		
Rat	0.48 mg/L (480 mg/m^3)	ECHA 2014
High Chronic/Repeat Dose Toxicity		
LOAEL (rats, oral, maternal toxicity)	51 mg/ kg bw/day	ECHA 2014
NOAEL (rats, oral, non-neoplastic effects)	7 mg/kg bw/day	ECHA 2014
NOAEL (rats, oral, reproductive toxicity, embryotoxicty)	68 mg/kg bw/day	ECHA 2014

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NDF – No data found within the limits of the search strategy

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity (IARC Group 1 or 2A)	No	IARC 2014 ECHA 2014
Mutagenicity/Genotoxicity (GHS Category 1A and 1B)	No	ECHA 2014
Reproductive Toxicity/Developmental toxicity (GHS Category 1, 1A and 1B)	No	ECHA 2014
Endocrine Disruption[1]	No	EC 2000
Hazard Band 3		
Carcinogenicity (IARC Group 2B)	No	IARC 2014 ECHA 2014
Mutagenicity/Genotoxicity (GHS Category 2)	No	ECHA 2014
Reproductive Toxicity/Developmental toxicity (GHS Category 2)	No	ECHA 2014
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg [2] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L [3] (or mg/m^3) (vapour)	No	ECHA 2014, see below
High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d [2]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes [3]	No	ECHA 2014, see below
Corrosive (irreversible effect)	Yes	ECHA 2014
Respiratory sensitiser	Yes	ECHA 2014
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes [3]	Yes	oral LOAEL, rats, of 51 mg/kg bw/day, ECHA 2014
Skin Sensitiser	Yes	ECHA 2014
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours) [3]	Yes	oral LD_{50}, rat, of 316 mg/kg bw, ECHA 2014
Irritant (reversible effect)	Yes	
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	No	
Explosive potential	No	
Hazard Evaluation (highest band) not including physical hazards	Hazard Band 3	**Corrosive to skin and respiratory sensitiser**
Uncertainty analysis /data confidence (out of 12 parameters)	12/12	**100%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2] milligrams per kilogram body mass (mg/kg) or milligrams per kilogram body mass per day (mg/kg/d)

[3] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed)". (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	NDF	
STEL	NDF	
Peak Limitation	0.41 mg/m^3 (Peak limitation)	Safe Work Australia 2014
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF	
Water, recreational	NDF	
Soil, residential	NDF	
Soil, commercial/industrial	NDF	

Footnotes:

OEL = Occupational Exposure Limit

TWA = 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

Qualifying Summary Comments

Glutaraldehyde is a colourless oily liquid which has a variety of uses. In Australia, it's primarily used as a cold disinfectant by the health care industry. Glutaraldehyde was declared a Priority Existing Chemical (PEC) in 1993 under the *Industrial Chemicals (Notification and Assessment) Act, 1989* due to adverse health concerns, which could results from individuals being exposed through the production, handling, use and disposal of glutaraldehyde. Glutaraldehyde is considered acutely toxic via the oral and inhalation route and is corrosive to the skin and eyes. Occupational exposure to glutaraldehyde has resulted in occupational asthma from inhalation, significant skin, respiratory system and eye irritation, as well as skin sensitisation in some cases from skin exposure. . The inhalation hazards associated with use of glutaraldehyde need to be managed in an occupational setting as it can cause asthma. Glutaraldehyde has been ranked in Hazard Band 3, based on the potential for it to be corrosive to the skin and eyes and a respiratory sensitiser. These effects were observed for both undiluted and diluted solutions of glutaraldehyde. It is noted that the rapid metabolism of glutaraldehyde in soil and the rapid biodegradation of glutaraldehyde in the aquatic environment, along with the fact that it is not expected to bioaccumulate (see the Ecotoxicology section of the cover addendum), limits the potential for glutaraldehyde to persist under general environmental conditions.

References

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EC (European Commission) 2000. *European Commission Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption, preparation of a candidate list of substances as a basis for priority setting, Final Report (Incorporating corrigenda to final report dated 21 June 2000)*. BKH Consulting Engineers, Delft, The Netherlands in association with TNO Nutrition and Food Research, Zeist, The Netherlands Available at http://ec.europa.eu/environment/chemicals/endocrine/strategy/substances_en.htm#priority_list, Accessed July 2014

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NICNAS (National Industrial Chemicals Notification and Assessment Scheme) 1994, *Priority Existing Chemical Assessment Report No.3 – Glutaraldehyde.*

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Created by:	MGT	Date: 10/12/2014
Reviewed by:	JF	Date and Revision: Rev0,12/12/2014 Rev1, 27/01/2015

APPENDIX C

Ecotoxicology Profiles

Project number: 127635006

ORGANIC

Name	Glutaraldehyde
Synonyms	Tentanedial, Alhydex, Cides, Glutaral
CAS Number	111-30-8
Molecular Formula	C5H8O2

Physical Properties	Value	Reference
PhaseState:	Liquid	HSDB 2011
Molecular Weight (g/mol):	100.12	HSDB 2011
Melting Point (°C):		
Boiling Point (°C):	188	HSDB 2011
Density / Specific Gravity (Enter Unit):	0.72	HSDB 2011
Vapour Pressure (mm Hg at 25°C):	0.6	HSDB 2011
Solubility (mg/L):	220,000.00	HSDB 2011
Henry's Law Constant (atm m³/mole):	0.000000024	HSDB 2011
Organic carbon partition coefficient (Koc):	120.00	HSDB 2011
Log organic carbon partition coefficient (log Koc):	2.08	Calculated
Log octanol - water partition coefficient (log Kow):	-3.30E-01	HSDB 2011

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	3.0226	EPISUITE 2011 v4.1
Biowin 4 (Primary Biodegradation):	4.0966	EPISUITE 2011 v4.1
EPISUITE Ready Biodegradability:	Biodegrades fast	EPISUITE 2011 v4.1
Biowin 7 (Anaerobic Model Prediction):	1.1592	EPISUITE 2011 v4.1
Fugacity_Air: (%)	0.395	EPISUITE 2011 v4.1
Fugacity_Water: (%)	40	EPISUITE 2011 v4.1
Fugacity_Soil: (%)	59	EPISUITE 2011 v4.1
Fugacity_Sediment: (%)	0.0755	EPISUITE 2011 v4.1
Bioconcentration factor (BCF):	3.2	HSDB 2011
Biotransformation half - life (Days):	0.05197	EPISUITE 2011 v4.1

Project number: 127635006

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Pseudokirchneriella subcapitata	Green algae	Plant EC50	GRO	Abundance	4	0.310	HSDB 2011
Daphnia magna	Water flea	Invertebrate EC50	ITX	Immobilisation	2	0.750	HSDB 2011
Pimephales promelas	Fathead minnow	Fish LC50	MOR	Mortality	4	5.4	HSDB 2011

Terrestrial Ecotoxicological Data

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Mice	Mammalian LD50	MOR	Mortality		100	HSDB 2011	mg/kg

Created By: Naomi Cooper Date: 10/12/2014

Checked By: Carolyn Brumley Date: 12/12/2014

APPENDIX D

Important Information

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